

## NOTES ON THE LIMESTONE OF YEALMPTON AND ITS ASSOCIATED ROCKS.

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THE limestone of Yealmpton is the largest isolated patch of that rock which occurs between the extensive limestone deposits of Plymouth and Torbay. This is of itself sufficient to cause considerable interest to attach to its conditions, and that interest is heightened by the discoveries of ossiferous caverns that have from time to time been made in the neighbourhood of Yealmpton village.

The Plymouth limestone breaks off to the eastward, about Sherford, having a total length from west to east of about  $6\frac{1}{2}$  miles. From its easterly termination to the western commencement of the Yealmpton limestone at Kitley is not far short of two miles; but it should be observed that the latter lies rather to the southward of the general line of strike of the former. The Yealmpton limestone itself is about two miles in length from west to east, and about half a mile in breadth. It does not attain so great an elevation as the slate hills by which it is bounded on the north and south; and is traversed from end to end by the river Yealm, which has partly found and partly wrought a kind of gorge. In these two respects its conditions resemble those of the Plymouth limestone, which is everywhere lower than the slate, and which gives passage to the rivers Plym and Tamar.

We have not far to look for the chief agent in forming the early channel of the Yealm. As at Plymouth the lime rocks were clearly fissured by the volcanic action, of which that place was either a chief or subordinate centre; so at Yealmpton we find an intrusive trap rock occupying a considerable area to the north of the village. This, heaving the limestone along its length, produced the fissure which the stream has since eroded to its present course. That the volcanic rock is intrusive is clearly proved. It underlies the limestone which,

as Dr. Holl states in his valuable paper on "The Older Rocks of South Devon and East Cornwall," has in parts been denuded off. And whilst the late Mr. J. C. Bellamy, in his *Natural History of South Devon*, notes that in places where the trap has come into contact with the limerock it has given the latter a green tinge (this I have not observed myself). I have been fortunate enough to find examples of clay slate, which by its agency have either been fused or baked into porcelain jasper.

In the paper on the rocks of Plymouth which I had the honour of laying before the Association two years since, reference was made to the essential difference between the rocks on the north and those on the south of the Plymouth limestone. Dr. Holl, holding the same views, calls the former the Lower and the latter the Upper South Devon Group. He states, moreover, that the upper group so expands beyond Plymstock as to pass on each side of the Yealampton limestone; and that at Yealampton there commences a long, narrow anticlinal axis, ranging thence to Brixham, which, with another to the north, has brought up the lower slates with a northern overthrust. These are statements to which it would be presumptuous in me, even were I so inclined, to take exception; and the only remark I have to make thereon is, that, so far as I have been able to ascertain, the anticlinal commences somewhat farther to the west than the point marked by Dr. Holl upon his map.

The general dip of the slate rocks in the neighbourhood is to the southward, running from  $30^{\circ}$ , or even less, up to  $80^{\circ}$ , in amount; but in direction rarely varying more than a few degrees to the east or west. Immediately to the north, however, of the limestone at Yealm Bridge, which, according to Dr. Holl, occupies the crest of the anticlinal, the slate dips north at an angle of  $80^{\circ}$ . In a quarry near Hall Torrs, west of this, on the line of strike, and immediately across the Yealm, dips of  $80^{\circ}$  south and of  $60^{\circ}$  north may be observed; but this may be due to the fact that the trap has intruded itself close by. The dip of the slate does, however, present several difficulties. If the cleavage has a general correspondence with the bedding, then the southerly dip is unquestionable; but from the mode of occurrence of some of the fossils found in it, it is plain that this is by no means always the case. Moreover, the country has been so disturbed by volcanic action that local variations are inevitable. On the hill to the north-west of Lynelham the slate may be seen absolutely vertical on the ridge, dipping on one side to the south and on the other

to the north, the cause being evidently upheaval by a mass of trap which shows itself hard by. And there is still another source of possible misconception, which, however, applies only to merely surface sections. It continually happens that the upper portions of the shales have been bent over so as to present a dip exactly the reverse of that of the body of the rock below. Where they are so bent, the laminae are always loose. This appears to have been caused by the original upheaval.

To return to the limestone. The dip varies considerably, and at some points it is difficult to ascertain the direction of the beds. At Yealm Bridge quarry the dip is a little west of south, at an angle of  $45^{\circ}$ ; but there are some shaly beds, indicating (as pointed out in my notice of the Plymouth rocks) that in part the deposition of the calcareous and argillaceous rocks was contemporaneous; and these are a good deal contorted. On the northern edge of the limestone near Hall Torrs, the dip is a little east of south, about  $30^{\circ}$ . At the old quarries, now abandoned, by the side of the river, and a little south-west of the village, the direction of the dip appears to be the same, but its amount  $60^{\circ}$ . At a quarry still further west, the last now open in that direction, the dip is south-west about  $40^{\circ}$ . The appearances seem to indicate that these variations are caused by the mode in which the mass of trap already referred to occurs.

With one exception, the general characteristics of the Yealmpton limestone may be said to resemble those of the Plymouth. It is vari-coloured, fossiliferous—abundantly so in parts—highly crystalline. But the exception is an important one. Magnesia does occur in the Plymouth limestone; but in much of that of Yealmpton it is present in such large quantities as to convert immense masses into dolomite, highly-crystalline layers of which are at times intercalated between the beds of the common limestone, whilst at some points the rock is wholly composed thereof.

My reference to the ossiferous caverns will be very brief. I have no desire to trespass upon ground already occupied by one so much more competent than myself.\* For many years a cavern has been known in the Old Quarry. It is, however, closed against visitors except by permission, and it does not appear that any bones were ever found there. In fact it has never been explored for that purpose. The appearance presented by the quarry shows, however, that the rock must

\* Vido *The Literature of the Caverns near Yealmpton*. By Mr. W. Pengelly, F.R.S., in the fourth volume of the *Transactions*, pp. 81-105.

have been perfectly honeycombed by fissures of various dimensions. Some of these we know to have been ossiferous; and indeed, during a cursory examination, I found in the remains of one what would seem to be a portion of the femur of some carnivorous animal. Within the past year or two a cavern has been discovered in the quarry at Torr, on the opposite side of the river; but this is also locked up, and I was unable to ascertain if any animal remains had been found therein. I was told not. At Yealm Bridge the progress of the quarrying works has revealed fissures similar to those in which large quantities of bones were found forty years ago. They open from the top of the quarry, and contain earth and a quantity of pebbles precisely similar to those which are to be found in the bed of the Yealm close by, evidently deposited there by that river when its bed was forty or fifty feet higher than at present.

Mr. Bellamy records the fact that at this quarry there was found a quantity of iron ore. This seems to be the only metalliferous deposit associated with either the Plymouth or the Yealmpton limestone, though calamine is said to have been found in the latter. At Mount Batten there is an iron lode, which has an east and west direction; and which at Laira Bridge has produced considerable quantities of ochre. Possibly this is the same lode that runs to the south of Plympton, producing hematite, and upon which mining operations of an exploratory character have been undertaken.

There is little to note concerning the Yealmpton slates. They are commonly either drab or leaden in colour, and mostly of a loose texture. Occasionally they yield slate which may be used for roofing purposes, and they are but very partially and sparingly fossiliferous.

Allusion has already been made to the fact that the trap on the north of Yealmpton has converted some of the slate into porcelain jasper. Yealmpton also yields the true jasper, but not in any large quantity; and the limestone contains fine examples of calcite. In the trap asbestos sometimes occurs.

The trappean rocks of the neighbourhood have a wider distribution than has been hitherto recorded. They vary considerably in character. Some are hard, tough greenstone, greatly in request for road metal. Others are ferruginous and rotten. Vesicular varieties are comparatively rare, and there are some so schistose in appearance that, apart from the connection, it would not be easy to pronounce at first sight upon their nature.